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FLORISTIC DIVERSITY OF A DISTURBED WESTERN OHIO FEN

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ABSTRACT

During the 1990–1992 growing seasons vegetation was surveyed in a Logan County, Ohio fen. This 23 ha site was subjected to intense substrate disturbance resulting from peat mining activities which took place from 1980 to 1985. Thousands of cubic meters of peat and marl were removed from the fen and virtually the entire surface area was affected by dredging activities. Surveys of the fen prior to mining indicate that the site was occupied mostly by shrub communities dominated by *Cornus* spp., *Rosa palustris,* and other woody species. However, shrubs are infrequent at the present time. Post-disturbance surveys documented a total of 208 vascular plant taxa, including 22 species listed as rare in Ohio. Several species are present which are disjunct from areas in the state where they normally occur, or are not known elsewhere in western Ohio.

Key Words: bog fen, disjuncts, peat mining, prairie fen, rare plants, substrate disturbance

INTRODUCTION

Fens are alkaline peatlands which survive as relict wetland communities scattered throughout glaciated Ohio. Prior to European settlement, peatlands were estimated to cover 74,000 ha in Ohio (Dachnowski, 1912). Recent work by Andreas and Knoop (1992) indicates that approximately 98% of the state's peatlands have been destroyed. The primary cause of this loss has been conversion of land for agricultural purposes, accounting for 85% of the total loss of peatlands. Additional factors contributing to the disappearance of these wetlands are recreation (vacation cottages, camps, etc.), modification of hydrology, mining and other development. Other more insidious factors causing a decrease in diversity and an eventual elimination of typical fen associations are natural succession into woody plant communities and invasion by non-native plants. Alien species, in particular *Rhamnus frangula* L. (European Buckthorn), have detrimentally impacted many of Ohio's fens. Left unchecked, this species can proliferate to the point of eliminating much of the native flora.

Numerous rare plant taxa, and a few species of rare animals, are confined to or exist primarily in fens in Ohio. Many of the plants require the combination of marl (calcium carbonate pre-

cipitate derived from artesian spring waters) substrate, cool subsurface soil temperatures, and saturated soil conditions. Most of the species which are exclusive to fens in Ohio occur in a wider variety of habitats elsewhere. In Ohio, many of these species are on the edge of their range, and therefore require the specialized combination of habitat parameters in fens to gain a competitive advantage over more generalized wetland species which are unable to tolerate the harsh conditions within fens. Rare plants exclusive to fens in Ohio include: *Carex flava* L., *Carex sterilis* Willd., *Cladium mariscoides* (Muhl.) Torr., *Eleocharis pauciflora* (Lightf.) Link., *Eriophorum viridicarinatum* (Engelm.) Fern., *Triglochin maritimum* L., *Triglochin palustre* L., *Tofieldia glutinosa* (Michx.) Pers., *Zigadenus elegans* Pursh var. *glaucus* (Nutt.) Preece, *Cypripedium calceolus* L. var. *parviflorus* (Salisb.) Fern., *Spiranthes romanzoffiana* Cham., *Deschampsia caespitosa* (L.) P. Beauv., *Cacalia plantaginea* (Raf.) Shinners, *Solidago ohioensis* Riddell, *Utricularia cornuta* Michx., *Myrica pensylvanica* Mirbel., *Salix myricoides* (Muhl.) J. Carey, and *Valeriana edulis* Nutt. var. *ciliata* (T. & G.) Cronq. (Anon., 1992). Uncommon animals often found in fens include *Clemmys guttata* Schneider (Spotted Turtle) and *Sistrurus catenatus* Rafinesque (Massasauga Rattlesnake).

STUDY AREA

The study site, known as McCracken Fen, is located in west-central Ohio near the city of Bellefontaine, county seat of Logan County (Figure 1). This region is characterized by low, rolling hills formed by a series of kames and eskers deposited by the Wisconsin ice sheet. McCracken Fen is situated on a large terminal moraine which spans most of Logan County. Artesian springs which emanate from deep gravel deposits are frequenct in this area, as evidenced by names of local towns; Bellefontaine (French for beautiful fountain), Big Springs, and Springhills. The abundance of springs had led to the formation of numerous fens in the Champaign-Clark-Logan county region (Schneider, 1992), although many of these now have been destroyed (Andreas and Knoop, 1992).

McCracken Fen is situtated in a bowl-like depression surrounded by rather abruptly sloping gravel ridges on three sides. The south side is bordered by a small tract of Elm-Ash swamp forest which grades into agricultural fields. The fen was mined for peat

Figure 1. Location of McCracken Fen, Logan County, Ohio.

and marl products over a period of approximately five years, beginning in 1980. Many tons of substrate were removed from nearly all areas of the peatland. This dredging caused intensive disturbance to the surface of the wetland, and is still obvious in the form of ditches, furrows, open flats, and artificial deepwater pools (Figure 2). In 1985, the mining company apparently went bankrupt, and operations abruptly ceased. Heavy equipment such as draglines, cranes, tractors, and a small peat packaging plant were abandoned and are still present at the site.

The hydrology of the fen is maintained by artesian springs entering the wetland from the east. Although mining activities altered the natural openings of these springs, they continue to flow

Figure 2. Post-disturbance aerial photograph of McCracken Fen, Logan County, Ohio. Taken June, 1990, by ODNR.

at a rapid rate. Attempts to drain McCracken Fen via ditches and drainpipes were unsuccessful, as the volume of water entering the fen appears to have offset the amount which was drained off.

METHODS

Field surveys of McCracken Fen began in September of 1989. A chance visit to the site by McCormac resulted in the discovery of *Scirpus smithii* Gray (Smith's Bulrush), which at that time was known from only one small, possibly extirpated, population in Ohio. During 1990, 1991 and 1992, eleven collecting trips were made to the fen, between April and October. Two hundred and eight species of vascular plants were collected and voucher specimens were deposited in the following herbaria: CLM, KE, MICH, MU, and OS (Holmgren et al., 1990). An effort was made to record frequency and abundance of all plant taxa, based on field observations, and using codes supplied by Reznicek and Catling (1989). Detailed information regarding plants listed as rare in Ohio (Anon., 1992) is on file in the Ohio Natural Heritage database.

Standard regional manuals were used for identification of spec-

imens, particularly Fernald (1950), Gleason and Cronquist (1991), and Voss (1972, 1985). Nomenclature follows Gleason and Cronquist (1991).

RESULTS AND DISCUSSION

Rare Plants. Of the 208 species of vascular plants collected in McCracken Fen, one is considered endangered in Ohio, seven are threatened, and fourteen are potentially threatened (Anon., 1992).

Many of these species are rare in Ohio due to their specificity of habitat, and the majority are obligate fen species. As most of the state's original fen communities have been destroyed or greatly altered, many of the plants typically associated with this type of wetland have become rare and local. Rare species are placed into categories based on guidelines established by the Division of Natural Areas and Preserves (Anon., 1992). Species classified as endangered in Ohio are restricted in distribution to an area delineated by three or fewer U.S. Geological Survey 7.5 minute topographic maps. Threatened species occur on between four and seven quadrangle maps or have fewer than ten total populations statewide. Potentially threatened species are believed to be declining in abundance in Ohio and have been placed in this "watch" category due to their dependence on fragile ecosystems which have become increasingly rare.

The presence of species with "threatened" (T) and "endangered" (E) status in McCracken Fen is noteworthy, and these plants are discussed individually below:

Betula pumila L. (T): This northern shrub is known from only six extant populations in Ohio, mostly in the northern part of the state. The nearest population to McCracken fen is at Cedar Bog in adjacent Champaign County, a well-studied site (Frederick, 1974) which is floristically similar to McCracken Fen.

Carex bebbii (L.H. Bailey) Fern. (T): Another northern species known from ca. eight sites in northern Ohio, most of which are on the lake plain of Lake Erie. The McCracken Fen population is disjunct from the nearest Ohio site by 120 km, and is one of the most southerly populations in the midwest.

Carex sartwellii Dewey. (T): This plant is known from about ten sites in Ohio, mostly in the western half of the state. Many years these populations remain largely sterile, thus rendering de-

tection difficult. Field observations by the authors in recent years suggest that fire, and possibly other forms of disturbance, may induce flowering.

Eleocharis flavescens (Poiret) Urban, var. *olivacea* (Torr.) Gleason. (T): This species is very habitat specific in Ohio, as all eight extant populations occur in seasonally exposed, saturated peat, usually on the drying shores of lakes or ponds. With the exception of a site in Champaign County, the nearest population to McCracken Fen is ca. 130 km to the north.

Pogonia ophioglossoides (L.) Ker Gawler. (T): This was one of the most exciting discoveries, as this orchid was reported only once before on the till plains of western Ohio, from a peat bog which straddled the Champaign-Logan county line and has since been destroyed. Only five small populations of Rose Pogonia are known to be extant in Ohio, primarily in the northeastern quarter of the state.

Scirpus smithii A. Gray. (E): One of the rarest plants in Ohio, Smith's Bulrush was known from only one site in Ohio, on the shore of Lake Erie in Ottawa County. The plant has not been seen at the Lake Erie site in recent years; therefore, the McCracken Fen population may be the only extant site in Ohio. It should be noted that we treat *Scirpus smithii* A. Gray and *S. purshianus* Fern. as distinct species; Ohio material of the former is easily separated from the latter. Gleason and Cronquist (1991) submerge these taxa under the name *Scirpus smithii.*

Sphenopholis obtusata (Michx.) Scribn. var. *obtusata* (T): Currently known from only five sites in Ohio, most records of this easily overlooked and/or misidentified species are from the western half of Ohio.

Utricularia intermedia Hayne. (T): Eight populations are known in Ohio, from glacial lakes in northern Ohio, and saturated marly ground of a few fens in west central Ohio.

Aliens. Non-native species accounted for 8% of the vascular flora of McCracken Fen, or 18 species. However only two of these, *Rhamnus frangula* and *Solanum dulcamara* L. have become established within the fen, although they are not yet common. The remaining alien species persist locally in the transition zone between upland and fen, or are occasional on drier hummocks in the fen. Whereas non-native plants are well-known colonizers of disturbed ground (Muenscher, 1935), the low incidence of aliens in the flora of McCracken Fen, in spite in the recent heavy dis-

turbance, may be attributable to three factors. The substrate of fens are consistently low in temperature, low in oxygen availability, and are nutrient deficient (Van der Valk, 1977). These factors create an environment suitable only for an assortment of plants which have adapted to these conditions, and may account for the relative lack of colonization by non-native species.

Disjuncts. Many species in the flora of McCracken Fen are of a northern and/or coastal plain affinity. A number of these plants reach the southern limits of their range in Ohio in the extreme northern and northeastern sections of the state, and also occur sparingly as disjuncts in the fens and bogs of central Ohio. Examples of this type of distribution which are found at McCracken Fen include *Betula pumila, Carex bebbii, Eleocharis flavescens* var. *olivacea, Eriophorum viridicarinatum, Rhynchospora alba* (L.) Vahl., *Scirpus smithii,* and *Utricularia intermedia* (Figure 3).

PRE-DISTURBANCE PLANT COMMUNITIES

Information regarding the condition of McCracken Fen prior to the mining operation is scarce; however the site was known to botanists and was visited several times. Pehaps the best documentation of pre-disturbance conditions are aerial photographs of the fen taken by the Ohio Department of Natural Resources (ODNR) in 1978 (Figure 4). These pictures indicate that the fen was largely vegetated by woody shrubs such as *Cornus* spp. and *Rosa palustris* Marshall. An extensive stand of *Scirpus acutus* Muhl. is also evident. When the 1978 photograph (Figure 4) is compared with a photo taken in 1992 (Figure 2), the change in composition of vegetation caused by the mining operating is evident.

Botanists Allison W. Cusick and Guy L. Denny, both employees of ODNR, also visited McCracken Fen in the mid-1970's, prior to mining. They state (pers. comm.) that the fen was practically impenetrable due to the dense shrub zones, and with the exception of *Potentilla fruticosa* L., no unusual or state-listed plants were observed.

POST-DISTURBANCE PLANT COMMUNITIES

Six distinct zones of vegetation exist in present-day McCracken Fen. With the exception of the open water habitat, and weedy

Eriophorum viridicarinatum

Rhynchospora alba

Eleocharis flavescens var. olivacea

Scirpus smithii

Utricularia intermedia

Betula pumila

Carex bebbii

Figure 3. Ohio distribution of species which occur as disjuncts in western Ohio fens, including McCracken Fen, Logan County, Ohio.

peripheral zone, these vegetation zones resemble those which occur naturally in many other undisturbed Ohio fens. As these zones were artifically created as a side-effect of the peat-mining operations, they differ in some respects from naturally occurring habitats. Within several of the zones there are also recognizable microhabitats.

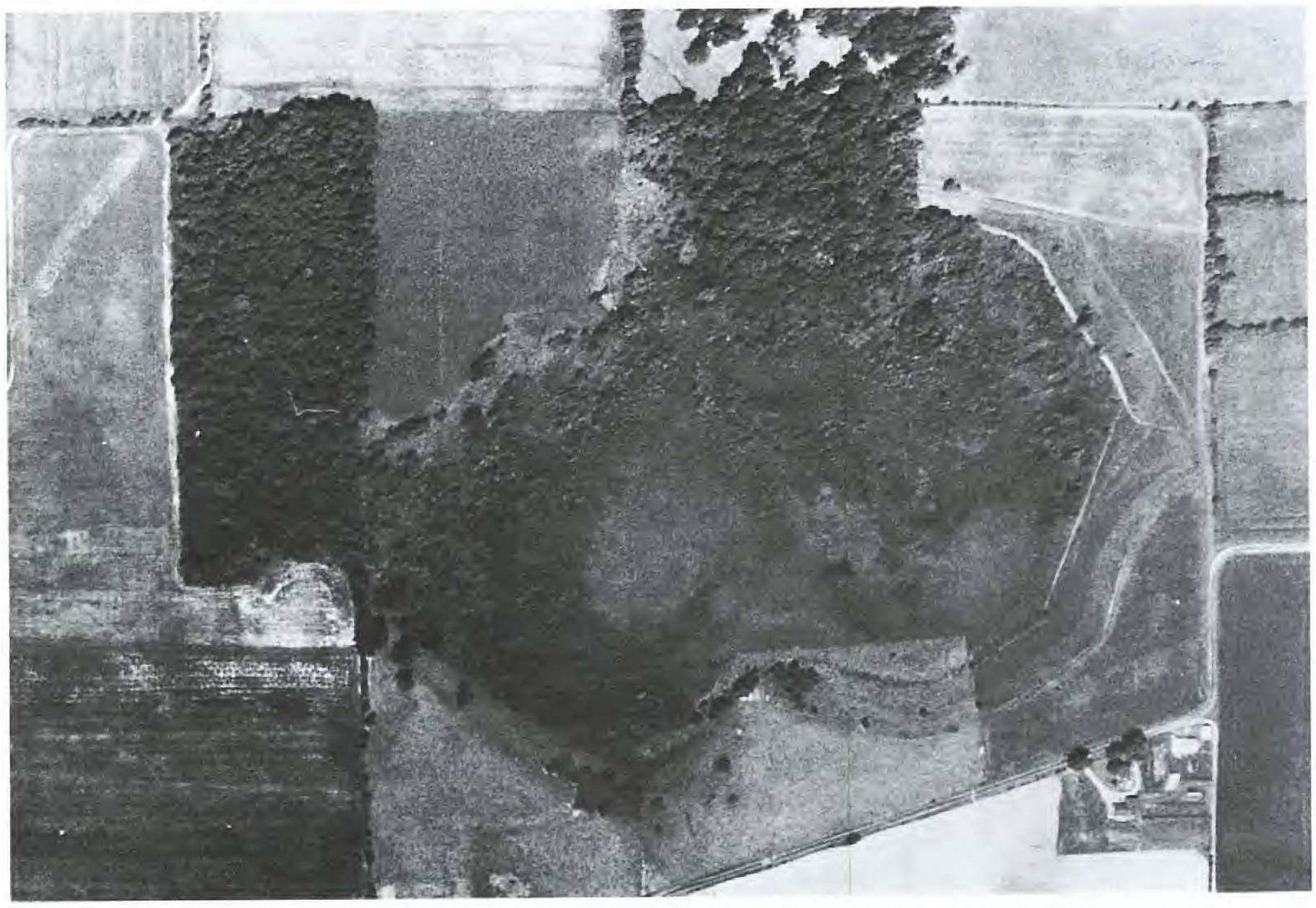

Figure 4. Pre-disturbance aerial photograph of McCracken Fen, Logan County, Ohio. Taken August, 1978, by ODNR.

Open Water Areas. This habitat shows the most visible effect of the mining activities. Two large areas, each ca. 1.5 ha in size, were dredged to a much greater depth than other areas of the fen, leaving ponds which vary from 30 cm to 5 m in depth. Fed by artesian springs, these ponds have exceptionally clear water and support twelve species of aquatic plants, as well as a number of species dependent on the open, marshy ground bordering the ponds. It is interesting that the composition of flora inhabiting the open water areas is similar to that which is found in nearby glacial lakes. In addition to the two large ponds, a number of much smaller open water areas exist in the fen, usually in the form of deeply dredged ditches.

Aquatic plants characteristic of the open water habitat include *Brasenia schreberi* J.F. Gmelin, *Lemna minor* L., *Najas flexilis* (Willd.) Rostkov & Schmidt, *Nuphar advena* (Aiton) Aiton f., *Nymphaea odorata* Aiton, *Potamogeton illinoensis* Morong, *P. pectinatus* L., and *Utricularia vulgaris* L.. Species typical of saturated open soil bordering water areas include *Alisma subcordatum* Raf., *Carex comosa* F. Boott., *C. lurida* Wahlenb., *Eleocharis palustris* L., *Eupatorium perfoliatum* L., *Leersia oryzoides*

(L.) Swartz, *Mimulus ringens* L., *Sagittaria latifolia* Willd., *Scirpus acutus,* and *Verbena hastata* L.

Marl Flats. Open marl flats provide habitat for some of the rarest obligate fen plants in Ohio. Marl flats are invariably associated with outflows of spring water containing calcium and magnesium salts. These water-borne minerals precipitate after reaching the surface and combine with peat to form a substratum of marl throughout the fen.

Water flow through McCracken Fen has been altered to the point where naturally forming marl flats are not present. However, marly peat flats have been created by the peat excavating process. In several areas, small flats were created when the overlying peat layer was removed, exposing the underlying marl. These artificial marl flats are saturated to the surface by ground water, and are habitat for an unusual assortment of plants, including many rare or uncommon species. Plant taxa typical of the marl flats include *Cyperus bipartitus* Torr., *C. flavescens* L., *Eleocharis tenuis* (Willd). Schultes var. *borealis* (Svenson) Gleason, *Fimbristylis autumnalis* (L.) Roemer & Schultes, *Hypericum majus* (A. Gray) Britton, *Juncus articulatus* L., *J. brachycephalus* (Englem.) Buchenau, *J. canadensis* J. Gay., *J. nodosus* L., *Rhynchospora alba, R. capillacea* Torr., *Scleria verticillata* Muhl., and *Spiranthes cernua* (L.) Rich. Noteworthy is the almost complete dominance of two families, the Cyperaceae and Juncaceae. The frequency of these two groups in soils that were heavily disturbed by mining activities suggests a strong capability to store seeds in a viable state for an extended period deep within the substratum.

Another type of flat occurs within McCracken Fen and is quite different in composition of substrate and cause of origin, than the above described marl flats. Autumnally exposed flats occur along the margins of the open water areas, due to a slight (±15 cm) drop in water levels, which begin to recede in mid-summer. By September these areas are fully exposed. The substrate of these shoreline flats is composed of unconsolidated, saturated peat which is very unstable, and low in diversity of flora. However, two of the rarest species present in the fen, *Eleocharis flavescens* var. *olivacea* and *Scirpus smithii,* occur in this habitat. Other species commonly found in this zone are: *Bidens cernua* L., *Cyperus odoratus* L., and *Ludwigia palustris* (L.) Elliott.

Potentilla Fruticosa Meadow. This is the largest plant community in the fen, occupying ca. 5 or 6 ha. This habitat appears

to be nearly a monoculture of *Potentilla* when viewed from a distance, although it is easily the most diverse zone in McCracken Fen. Slight changes in moisture regime influence supporting vegetation, as does the presence of *Sphagnum*. The driest areas of the meadow are relatively low in species diversity, while wetter areas support an impressive array of plants. Some of the dominant species in this community include *Aster puniceus* L., *A. umbellatus* Miller, *Campanula aparinoides* Pursh, *Cladium mariscoides*, *Eupatorium maculatum* L., *Galium tinctorium* L., *Lobelia kalmii* L., *Muhlenbergia glomerata* (Willd.) Trin., *Potentilla fruticosa*, *Scutellaria lateriflora* L., *Solidago ohioensis*, *S. patula* Muhl., *S. rugosa* Miller, *Thelypteris palustris* Schott., and *Toxicodendron vernix* (L.) Kuntze.

One small section in the wettest area of the *Potentilla* meadow contains a lush growth of *Sphaghum* sp., and harbors several vascular plants found nowhere else in McCracken Fen. These are *Calopogon tuberosus* (L.) BSP., *Drosera rotundifolia* L., *Epilobium leptophyllum* Raf., *Eriophorum viridicarinatum*, and *Pogonia ophioglossoides*.

Graminoid Meadow. This is the rarest vegetation zone, occupying only a small (<5%) area of the total fen. Two different types of meadow are present, one dominated by grass (Poaceae) and the other composed primarily of sedges (Cyperaceae). The grass dominated meadow is ca. 0.4 ha in size, and is a virtual monoculture of *Calamagrostis stricta* (Timm.) Koeler. Species diversity in this meadow is quite low.

The sedge meadows are quite small, averaging only a few square meters. These occur primarily within the *Potentilla fruticosa* meadow, as small, randomly scattered openings. The dominant species found in the sedge meadows include *Aster borealis* Prov., *Carex flava*, *C. interior* L. Bailey, *C. leptalea* Wahlenb., *Epilobium coloratum* Biehler, *Scutellaria galericulata* L., and *Triadenum fraseri* (Spach) Gleason.

Shrub Zone. In contrast to conditions in the fen prior to mining, shrub zones now cover a relatively small area. Two distinct areas of this habitat, covering ca. 3–4 ha, are present. One of the shrub zones is dominated primarily by *Cornus amomum* Miller and *Rosa palustris*. This area is one of the least diverse habitats in the fen, as the dense, virtually impenetrable thickets exclude most herbaceous growth. The other shrub zone is dominated by a variety of woody species and shade tolerant herbaceous plants.

Dominant woody species include *Betula pumila, Cornus amomum, Fraxinus pennsylvanica* Marshall, *Ilex verticillata* (L.) A. Gray, *Populus deltoides* Marshall, *Rosa palustris, Salix discolor* Muhl., *S. sericea* Marshall, and *Ulmus rubra* Muhl. The understory herbaceous stratum of this thicket is quite diverse. Some of the dominant species include *Agrimonia parviflora* Aiton, *Aster lateriflorus* (L.) Britton, *Boehmeria cylindrica* (L.) Swartz, *Clematis virginiana* L., *Cuscuta gronovii* Willd., *Galium tinctorium, Glyceria striata* (Lam.) A. Hitchc., *Impatiens capensis* Meerb., *Onoclea sensibilis* L., *Osmunda regalis* L., and *Solidago gigantea* Aiton.

Weedy Peripheral Zone. Few non-native plant species have attained a foothold within McCracken Fen, the two notable exceptions being *Rhamnus frangula* and *Solanum dulcamara.* As most of the perimeter of this fen grades abruptly into dry, gravelly slopes, much of which has been disturbed by mining activities, there exists a narrow zone characterized by non-native species bordering the fen. Most of these alien plants do not penetrate far into the fen, and for the most part, do not occur in heavy concentrations. Two species which have become locally abundant in wetter areas of this zone are *Phalaris arundinacea* L. and *Typha angustifolia* L.

Some of the more common non-native plants occurring in the weedy peripheral zone include *Achillea millefolium* L., *Brassica nigra* L., *Chrysanthemum leucanthemum* L., *Convolvulus arvensis* L., *Daucus carota* L., *Nepeta cataria* L., and *Setaria viridis* (L.) P. Beauv.

FLORISTIC COMPARISON WITH OTHER OHIO FENS

Stuckey and Denny (1981) analyzed the floristic affinities of Ohio's fens. They concluded that two distinctive types of fens occurred in the state. They used the term prairie fen to describe fens in west-central and south-central Ohio. These fens have a distinctive floristic affinity with the wet, tall-grass prairies of the midwestern United States. The term bog fen was introduced to describe fens which occur in northeastern and extreme northwestern Ohio. These fens share many species with Ohio's kettle bogs. These species have northern affinities and are often abundant in the boreal fens of northern Michigan, northern Minnesota and Canada. Stuckey and Denny (1981) recognized that Cedar

Bog, a fen in west-central Ohio, was unique to the state in that its flora included both the prairie and boreal elements. McCracken Fen, which is located 32 km north of Cedar Bog, was relatively unknown until recently and was not discussed by Stuckey and Denny. This fen has some of the boreal species which otherwise occur mostly in northern fens or at Cedar Bog. These species include *Betula pumila, Eriophorum viridicarinatum, Rhynchospora alba* and *Pogonia ophioglossoides.* Another interesting facet of McCracken Fen's flora is the absence of many of the species of wet prairie affinity which are so characteristic of all of the other fens in this part of the state. Examples of species typical of Ohio prairie fens which do not occur at McCracken Fen include *Andropogon gerardii* Vitman, *Cacalia plantaginea* (Raf.) Shinners, *Coreopsis tripteris* L., *Liatris spicata* (L.) Willd., and *Silphium terebinthinaceum* Jacq.

CONCLUSIONS

Although no thorough surveys were made of McCracken Fen prior to the mining operation, evidence strongly suggests that the study area was in an advanced state of succession. Pre-mining photographs and accounts of observers indicate that shrub zones blanketed most of the fen, greatly reducing diversity. Mining activities removed most of the shrub zones, as well as some of the substrate. During the mining process, soils in the fen were heavily disturbed by the heavy equipment used to excavate the peat. It would seem likely that the combination of eliminating most of the shrub zones, thus restoring open fen meadow/marl flat habitat, and stimulating the seedbank by disrupting the substrate, resulted in increased diversity. Many of the plant taxa now present in McCracken Fen are characteristic of fens in Ohio, yet it is unlikely that they colonized the site from outside sources, as there are no other fens in the immediate vicinity. The dramatic shift in vegetation resulting from the mining operation suggests that fen soils are capable of storing large, viable seedbanks, and that restoration of fens in advanced successional states is possible.

ANNOTATED LIST OF THE VASCULAR PLANTS OF MCCRACKEN FEN, LOGAN COUNTY, OHIO

All species included on this list are represented by voucher specimens deposited in herbaria, as indicated following each spe-

cies. Nomenclature and phylogenetic order follow Gleason and Cronquist (1991). Each species is assigned a frequency code, as follows: rare, occasional, or abundant; and local, scattered or widespread (Reznicek and Catling, 1989). Habitat(s) in which each species occurs is given, using the following abreviations: GM (Graminoid Meadows), MF (Marl Flats), OW (Open Water), PM (*Potentilla fruticosa* Meadow), SZ (Shrub Zones) and WP (Weedy Peripheral Zone). Finally, our collection numbers for all taxa are given. Superscripts preceding species' names indicate: 1, non-native; 2, endangered; 3, threatened; and 4, potentially threatened.

PTERIDOPHYTES

EQUISETACEAE

Equisetum fluviatile L.—Occasional and local in SZ (*3675* OS).

OSMUNDACEAE

Osmunda regalis L.—Occasional and scattered in SZ (*1692* OS; *2724* MU).

ASPLENIACEAE

Thelypteris palustris Schott.—Abundant and widespread in PM, GM, and SZ (*3181* OS).

Dryopteris cristata (L.) A. Gray—Occasional and local in SZ (*4065* MU).

ONOCLEACEAE

Onoclea sensibilis L.—Occasional and local in SZ (*3651* OS).

DICOTYLEDONS

NYMPHAEACEAE

Nuphar advena (Aiton) Aiton f.—Abundant and local in OW (*2415* MU, OS).

Nymphaea odorata Aiton—Abundant and local in OW (*2620* CLM).

CABOMBACEAE

Brasenia schreberi J.F. Gmelin—Occasional and local in OW (*2417* MU).

RANUNCULACEAE

Caltha palustris L.—Rare and local in SZ (*4525* CLM, MU).

Anemone virginiana L.—Rare and local in PM (*3917* KE).

Clematis virginiana L.—Occasional and local in SZ (*2880* MU, OS).

Ranunculus recurvatus Poiret—Rare and local in SZ (*3650* OS).

R. abortivus L.—Rare and local in SZ (*3649* OS).

BERBERIDACEAE

Podophyllum peltatum L.—Rare and local in SZ (*4527* MU).

PLATANACEAE

Platanus occidentalis L.—Rare and local in SZ (*3915* OS).

ULMACEAE

Ulmus rubra Muhl.—Occasional and local in SZ (*3666* OS).

URTICACEAE

Urtica dioica L. var. *procera* (Muhl.) Wedd.—Occasional and scattered in WP (*3173* OS).

Boehmeria cylindrica (L.) Swartz—Occasional and scattered in OW, PM, and SZ (*3179* MU).

Pilea pumila (L.) A. Gray—Occasional and local in SZ (*3182* OS).

BETULACEAE

[3]*Betula pumila* L.—Occasional and local in PM and SZ (*2616* CLM, OS).

PORTULACACEAE

Claytonia virginica L.—Rare and local in SZ (*4528* MU).

POLYGONACEAE

[1]*Rumex crispus* L.—Rare and local in WP (*3671* OS).

Polygonum lapathifolium L.—Occasional and scattered in OW, WP (*3165* OS, *3347* OS).

P. pensylvanicum L.—Occasional and scattered in OW (*3162* OS).

[1]*P. hydropiper* L.—Rare and local in OW (*3190* OS).

P. punctatum Elliott—Occasional and scattered in OW (*3050* OS).
[1]*P. persicaria* L.—Rare and scattered in OW and WP (*3049* OS).
P. sagittatum L.—Occasional and scattered in SZ (*3174* MU).
P. scandens L.—Rare and local in SZ (*3049* OS).

CLUSIACEAE

Hypericum punctatum Lam.—Rare and local in MF (*2883* OS; *3028* OS).
H. multium L.—Occasional and local in MF (*1694* KE; *2876* MICH; *3029* MICH).
[4]*H. majus* (A. Gray) Britton—Occasional and local in MF (*2877* MICH; *3043* OS).
Triadenum fraseri (Spach) Gleason—Occasional and scattered in GM, OW, and PM (*1684* OS).

DROSERACEAE

[4]*Drosera rotundifolia* L.—Occasional and local in PM (*2611* OS).

VIOLACEAE

Viola sororia Willd.—Occasional and scattered in PM, SZ, and WP (*4535* MU).
V. macloskeyi F. Lloyd—Occasional and local in SZ (*4526* KE, MU).

SALICACEAE

Populus grandidentata Michx.—Rare and local in SZ (*2614* OS).
P. deltoides Marshall—Occasional and scattered in SZ and WP (*3643* OS).
Salix amygdaloides Andersson—Rare and local in WP (*3645* OS).
S. lucida Muhl.—Occasional and local in SZ (*3674* MU).
S. exigua Nutt.—Occasional and local in SZ and WP (*2617* MU; *3644* OS).
S. sericea Marshall—Occasional and local in SZ (*3655* OS).
S. discolor Muhl.—Occasional and local in SZ (*3191* OS; *3656* CLM).

BRASSICACEAE

[1]*Brassica nigra* L.—Rare and local in WP (*4785* MU).

Rorippa palustris (L.) Besser—Rare and local in MF (*4769* MU).

PRIMULACEAE

Lysimachia quadriflora Sims.—Abundant and widespread in GM, MF, and PM (*4766* MU).

L. thyrsiflora L.—Rare and local in SZ (*2420* KE).

GROSSULARIACEAE

Ribes americanum Miller—Occasional and local in SZ (*3661* OS; *4529* MU).

SAXIFRAGACEAE

Penthorum sedoides L.—Occasional and scattered in GM, OW, and PM (*3164* OS).

ROSACEAE

Fragaria virginiana Duchesne—Rare and local in WP (*4531* MU).

Potentilla norvegica L.—Rare and local in WP (*3654* OS; *3916* KE).

P. fruticosa L.—Abundant and local in PM (*1672* MU; *1706* OS).

Geum canadense Jacq.—Rare and local in SZ (*3038* OS).

G. laciniatum Murray—Occasional and scattered in PM, SZ, and WP (*3037* MU).

Rubus occidentalis L.—Occasional and scattered in SZ (*4771* MU).

Agrimonia parviflora Aiton—Occasional and scattered in PM and SZ (*3176* MU).

Rosa palustris Marshall—Abundant and scattered in SZ (*4783* MU).

Amelanchier spicata (Lam.) K. Koch.—Rare and local in SZ (*4534* OS).

LYTHRACEAE

Lythrum alatum Pursh—Occasional and scattered in MF (*3346* KE, OS).

Epilobium leptophyllum Raf.—Rare and local in PM (*3039* MU; *3160* OS).

E. coloratum Biehler—Occasional and scattered in GM, OW, and PM (*3189* OS).

Oenothera biennis L.—Rare and local in MF and WP (*2881* MU).

CORNACEAE

Cornus amomum Miller—Abundant and scattered in SZ (*3032* OS; *3662* MU).

Cornus sericea L.—Occasional and scattered in SZ (*2418* MU, OS).

AQUIFOLIACEAE

Ilex verticillata (L.) A. Gray—Occasional and local in SZ (*1685* OS; *3163* KE; *3652* MU).

RHAMNACEAE

[1]*Rhamnus frangula* L.—Occasional and scattered in PM and SZ (*4061* MU).

VITACEAE

Parthenocissus vitacea (Knerr) A. Hitchc.—Rare and local in PM (*4778* MU, OS).

Vitis riparia Michx.—Occasional and local in SZ (*3665* OS).

ANACARDIACEAE

Rhus glabra L.—Rare and local in WP (*4765* MU).

Toxicodendron vernix (L.) Kuntze—Occasional and scattered in PM and SZ (*1703* OS).

OXALIDACEAE

Oxalis stricta L.—Occasional and scattered in MF, PM, and WP (*3033* MU).

BALSAMINACEAE

Impatiens capensis Meerb.—Abundant and scattered in OW and SZ (*4066* MU; *4780* MU).

APIACEAE

Sanicula gregaria E. Bickn.—Rare and local in SZ (*3668* OS).

[1]*Daucus carota* L.—Occasional and scattered in WP (*3025* OS).

Cicuta bulbifera L.—Occasional and local in OW (*3168* OS).

GENTIANACEAE

Gentiana andrewsii Griseb.—Occasional and local in PM and SZ (*3175* MU; *3331* MU).

APOCYNACEAE

Apocynum cannabinum L.—Occasional and scattered in PM and WP (*3657* OS).

ASCLEPIADACEAE

Asclepias incarnata L.—Occasional and scattered in GM, PM, and OW (*3027* CLM).

SOLANACEAE

[1]*Solanum dulcamara* L.—Occasional and scattered in OW, PM, and SZ (*3653* OS).

CONVOLVULACEAE

[1]*Convolvulus arvensis* L.—Rare and local in WP (*3647* OS).

CUSCUTACEAE

Cuscuta gronovii Willd.—Occasional and scattered in OW, PM, and SZ (*1695* MU, OS).

BORAGINACEAE

[1]*Cynoglossum officinale* L.—Rare and local in WP (*3659* OS).

VERBENACEAE

Verbena hastata L.—Occasional and scattered in GM, OW, PM, and WP (*2722* OS; *3024* OS).

LAMIACEAE

Scutellaria lateriflora L.—Occasional and widespread in GM, OW, PM, SZ, and WP (*3185* MU).

S. galericulata L.—Occasional and scattered in GM, OW, and PM (*2618* CLM; *2725* MU).
S. nervosa Pursh—Occasional and local in OW and WP (*4781* MU).
Lycopus virginicus L.—Occasional and scattered in GM, OW, and PM (*3170* MU).
L. americanus Muhl.—Occasional and scattered in GM, OW, and PM (*3188* OS).
[1]*Nepeta cataria* L.—Rare and local in WP (*3914* KE).
Prunella vulgaris L.—Occasional and scattered in PM, SZ, and WP (*3030* OS).

OLEACEAE

Fraxinus pennsylvanica Marshall—Rare and local in SZ (*4770* MU).

SCROPHULARIACEAE

Mimulus ringens L.—Occasional and scattered in OW and PM (*2879* OS).
Agalinis purpurea (L.) Pennell—Occasional and scattered in GM, MF, OW, and PM (*1699* OS).

LENTIBULARIACEAE

[3]*Utricularia intermedia* Hayne—Rare and local in OW (*3334* KE).
U. vulgaris L.—Abundant and local in OW (*2621* CLM; MU).
U. gibba L.—Occasional and local in OW (*3042* OS).

CAMPANULACEAE

Campanula aparinoides Pursh—Abundant and scattered in GM and PM (*2723* MU; *4776* MU).
Lobelia kalmii L.—Occasional and widespread in GM and PM (*1700* OS).
L. siphilitica L.—Occasional and scattered in OW, PM, SZ, and WP (*3186* MU).

RUBIACEAE

Galium trifidum L.—Occasional and local in PM (*2885* OS; *3034* MU).

G. tinctorium L.—Occasional and scattered in GM, OW, PM, and SZ (*3918* CLM).
G. triflorum Michx.—Rare and local in SZ (*3921* KE).
G. aparine L.—Rare and local in SZ and WP (*3648* OS).

CAPRIFOLIACEAE

Viburnum lentago L.—Rare and local in SZ (*3664* OS).
Sambucus canadensis L.—Occasional and local in SZ (*3810* MU).

VALERIANACEAE

Valerianella umbilicata (Sulliv.) A. Wood—Rare and local in OW and WP (*2613* OS).

ASTERACEAE

Rudbeckia hirta L.—Occasional and local in WP (*3040* MU).
Bidens cernua L.—Occasional and scattered in MF, OW, PM, and WP (*1690* MU).
B. coronata (L.) Britton—Occasional and scattered in MF, OW, PM, and WP (*1675* MU; *1683* OS).
Ambrosia artemisiifolia L.—Rare and local in WP (*3159* MU).
[1]*Achillea millefolium* L.—Occasional and local in WP (*4774* MU).
[1]*Chrysanthemum leucanthemum* L.—Occasional and local in WP (*4777* MU).
Senecio aureus L.—Occasional and scattered in PM and WP (*4530* MU).
Erechtites hieracifolia (L.) Raf.—Rare and local in WP (*3333* OS).
Solidago patula Muhl.—Occasional and scattered in PM (*1707* MU).
S. rugosa Miller—Occasional and scattered in PM and WP (*1696* OS).
S. gigantea Aiton—Occasional and scattered in PM and WP (*3046* MU; *4069* KE).
S. canadensis L.—Occasional and local in WP (*4986* MU).
[4]*S. ohioensis* Riddel—Abundant and widespread in PM (*1677* MU).

S. riddellii Frank—Rare and local in PM (*1702* CLM).
Euthamia graminifolia (L.) Nutt.—Occasional and local in WP (*3158* MU).
Aster borealis Prov.—Rare and local in PM (*1705* OS).
A. puniceus L.—Abundant and widespread in GM, OW, PM, and WP (*1674* OS).
A. praealtus Poiret—Occasional and scattered in PM (*1681* OS).
A. lateriflorus (L.) Britton—Occasional and scattered in GM, PM, and WP (*1701* OS).
A. pilosus Willd.—Occasional and local in WP (*1687* OS).
A. novae-angliae L.—Rare and local in WP (*4985* MU).
A. umbellatus Miller—Abundant and widespread in GM and PM (*1704* OS).
Erigeron strigosus Muhl.—Rare and local in WP (*3036* OS).
Conyza canadensis (L.) Cronq.—Rare and local in WP (*3167* MU).
Eupatorium maculatum L.—Occasional and scattered in GM, OW, and PM (*1682* MU).
E. perfoliatum L.—Occasional and scattered in OW and PM (*3184* MU).
Cirsium muticum Michx.—Occasional and widespread in PM (*1697* OS).
[1]*C. vulgare* (Savi) Tenore—Occasional and scattered in WP (*3035* OS).
[1]*Taraxacum officinale* Weber—Rare and scattered in PM and WP (*4532* MU).
[1]*Cichorium intybus* L.—Occasional and local in WP (*4784* MU).

MONOCOTYLEDONS

ALISMATACEAE

Alisma subcordatum Raf.—Occasional and scattered in OW (*3023* CLM).
Sagittaria latifolia Willd.—Occasional and scattered in OW (*3026* MU).

POTAMOGETONACEAE

Potamogeton pectinatus L.—Abundant and widespread in OW (*4060* OS).
P. illinoensis Morong—Abundant and widespread in OW (*2728* OS, CLM; *2886* OS, CLM; *3049* OS).

NAJADACEAE

Najas flexilis (Willd.) Rostkov & Schmidt—Abundant and widespread in OW (*3992* MU).

LEMNACEAE

Lemna minor L.—Abundant and scattered in OW (*3336* OS).

COMMELINACEAE

[1]*Commelina communis* L.—Rare and local in WP (*3157* MU).

JUNCACEAE

Juncus canadensis J. Gay—Occasional and scattered in MF and PM (*1676* OS; *3172* MU).

J. brachycephalus (Engelm.) Buchenau—Occasional and scattered in MF (*1679* OS; *1686* MU).

J. torreyi Cov.—Occasional and scattered in GM, MF, and PM (*3057* CLM).

J. nodosus L.—Occasional and local in MF (*4782* MU).

J. articulatus L.—Occasional and scattered in MF (*3056* CLM; *4988* OS).

J. tenuis Willd. var. *dudleyi* (Wieg.) F.J. Herm.—Occasional and widespread in GM, MF, OW, PM, and WP (*3192* MU; *3660* MU).

CYPERACEAE

[2]*Scirpus smithii* A. Gray—Abundant and scattered in MF (*91671* OS; *1698* MICH; *3161* MU; *3345* KE).

S. acutus Muhl.—Occasional and local in OW (*3045* OS; *4779* MU).

S. validus Vahl.—Occasional and local in OW (*3183* OS).

S. fluviatilis (Torr.) A. Gray—Rare and local in GM (*4767* MU).

S. atrovirens Willd.—Occasional and scattered in OW (*2727* MU; *3055* OS).

S. pendulus Muhl.—Rare and local in GM (*4769* MU).

S. cyperinus (L.) Kunth.—Occasional and local in OW (*3171* MU).

[4]*Eriophorum viridicarinatum* (Engelm.) Fern.—Rare and local in PM (*2612* CLM, OS).

Eleocharis tenuis (Willd.) Schultes var. *borealis* (Svenson) Glea-

son—Occasional and scattered in GM and MF (*2623* CLM, OS; *3058* OS; *4070* MICH).

E. palustris L.—Occasional and scattered in OW (*3332* MU).

[3]*E. flavescens* (Poiret) Urban var. *olivacea* (Torr.) Gleason—Abundant and local in MF (*3166* OS; *3348* KE).

Fimbristylis autumnalis (L.) Roemer & Shultes—Abundant and scattered in MF (*1688* OS; *1693* MU; *3044* CLM).

[4]*Rhynchospora alba* (L.) Vahl.—Occasional and local in MF (*2882* MU, OS).

R. capillacea Torr.—Abundant and scattered in MF (*1691* MU).

[4]*Cladium mariscoides* (Muhl.) Torr.—Occasional and local in PM (*2884* OS).

Cyperus strigosus L.—Occasional and scattered in OW (*3051* CLM).

C. odoratus L.—Occasional and scattered in MF (*4073* MU).

C. flavescens L.—Occasional and local in MF (*4073* MU).

C. bipartitus Torr.—Occasional and local in MF (*1678* OS).

Dulichium arundinaceum (L.) Britton—Occasional and local in OW (*2878* MU).

[4]*Scleria verticillata* Muhl.—Occasional and scattered in MF and PM (*3041* OS).

Carex leptalea Wahlenb.—Abundant and scattered in GM and PM (*2419* CLM, OS).

[3]*C. sartwellii* Dewey—Rare and local in PM (*9001* OS).

C. vulpinoidea Michx.—Occasional and scattered in OW and WP (*2427* MU, OS; *2622* OS).

C. stipata Muhl.—Occasional and scattered in OW and WP (*2425* MU).

[4]*C. diandra* Schranck.—Rare and local in PM (*3658* OS).

C. interior L. Bailey—Occasional and scattered in GM and PM (*2430* MICH; *2431* OS).

[3]*C. bebbii* (L.H. Bailey) Fern.—Rare and local in PM (*2627* MICH; *3672* OS).

[4]*C. suberecta* (Olney) Britton—Rare and scattered in GM and PM (*2421* MICH, MU; *2628* MICH).

[4]*C. alata* T. & G.—Rare and local in PM (*2629* MICH; *3673* OS).

C. tetanica Schk.—Occasional and scattered in GM and PM (*2426* OS).

C. granularis Muhl.—Occasional and scattered in OW and WP (*2424* MU).

[4]*C. flava* L.—Occasional and widespread in GM and PM (*2423* CLM, MU, OS).

C. crinita Lam.—Occasional and scattered in OW and WP (*3350* MU).
C. comosa F. Boott—Occasional and scattered in OW and WP (*2625* OS; *3663* MU).
C. lacustris Willd.—Occasional and scattered in OW (*2429* OS).
[4]*C. utriculata* F. Boott—Occasional and scattered in OW (*2626* OS; *3667* MU).
C. lurida Wahlenb.—Occasional and scattered in OW and WP (*2428* MU, OS; *3919* KE).

POACEAE

Leersia oryzoides (L.) Swartz—Occasional and scattered in OW and WP (*3178* OS).
Festuca subverticillata (Pers.) E. Alexeev.—Rare and local on hummocks in SZ (*3670* OS).
[3]*Sphenopholis obtusata* (Michx.) Scribn. var. *obtusata*—Rare and local in PM (*3669* MU).
Phalaris arundinacea L.—Abundant and local in WP (*2721* OS; *4775* MU).
[4]*Calamagrostis stricta* (Timm) Koeler—Abundant and local in GM (*3920* MU).
Agrostis hyemalis (Walter) BSP. var. *scabra* (Willd.) Blomq.—Occasional and scattered in MF, PM, and WP (*4072* OS).
[1]*Phleum pratense* L.—Rare and local in PM (*4772* MU).
Muhlenbergia mexicana (L.) Trin.—Occasional and scattered in PM (*3177* OS).
M. glomerata (Willd.) Trin.—Occasional and scattered in PM (*4068* MU).
Panicum dichotomiflorum Michx.—Occasional and scattered in WP (*4071* MU).
P. flexile (Gattinger) Scribn.—Occasional and scattered in MF, PM, and WP (*3054* OS).
P. lanuginosum Elliott var. *implicatum* (Scribn.) Fern.—Occasional and scattered in PM and WP (*3053* OS).
Echinochloa muricata (P. Beauv.) Fern.—Occasional and scattered in OW and WP (*3187* MU; *4987* OS).

TYPHACEAE

Typha latifolia L.—Abundant and scattered in OW and WP (*3059* MU).
[1]*T. angustifolia* L.—Occasional and scattered in WP (*4773* MU).

IRIDACEAE

Iris virginica L.—Occasional and scattered in OW and PM (*2416* MU, OS).

ORCHIDACEAE

Spiranthes cernua (L.) Rich.—Occasional and local in MF (*3167* CLM, OS).

Habenaria lacera (Michx.) Lodd.—Rare and local in SZ (*2720* OS).

[3]*Pogonia ophioglossoides* (L.) Ker Gawler—Occasional and local in PM (*2609* CLM, OS).

[4]*Calopogon tuberosus* (L.) BSP.—Rare and local in PM (*2719* OS).

Liparis loeselii (L.) Rich.—Rare and local in SZ (*2610* CLM).

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